A Small Econometric Model of the Zambian Economy

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Abstract

This paper estimates a small macroeconometric model of the Zambian economy. It is based on annual data from 1967 to 1997 and provides projections for 1998 and 1999. The estimates are derived using Three Stage Least Squares (3SLS) method for simultaneous equations systems. Despite the fact that some of the estimated relations yield coefficients that are contrary to the theoretical expectations and the data include a long period in which key macroeconomic variables were manipulated by government, the results provide some useful insights regarding the operation of the Zambian economy and its future prospects. First, the model correctly measures the key dimensions of the economic retrogression that has occurred in Zambia. Large budget deficits led to rapid growth of money supply. Inflation accelerated and with a fixed exchange rate debt accumulated rapidly. Second, the full-information estimation method provides a coherent approach for understanding the various interactions among the principal macroeconomic variables. Third, the projection results suggest useful directions for future policy reform. Two of these are the revival of the mining sector and the promotion of agriculture. Fourth, the overall results point to a highly negative impact of government intervention in the economy. Future policies should carefully weigh the potential benefits against the adverse effects. And fifth, the model clearly illustrates the complementary dimensions of policy reform. Monetary, fiscal, exchange rate and debt management policies have to be modified together in ways that promote growth and development.

Keywords: Macroeconomic analysis of economic development, economic growth, forecasting, policy objectives, policy design.

JEL Codes: O1, O11, E, E1, E17, E61.

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1. Introduction

This paper presents a small econometric model of Zambia and discusses its implications. Our objective is to draw upon the major historical trends to derive potential future opportunities for the Zambian economy. This exercise supports our ongoing effort to identify the policies needed to move the Zambian economy towards a path of rapid, sustained growth and development[1].

The econometric model serves three purposes. It illustrates the pattern of macroeconomic change in Zambia over the last 25 years. It measures the strength and direction of the main economic relationships. And, it suggests fruitful areas for promoting policy reform.

Section 2, which follows, gives a brief overview of the Zambian economy. Section 3 introduces the model, explains its structure, and discusses the results. The projection results and possible extensions to the model are examined in Section 4. Section 5 has concluding comments. There are four annexes. Annex A consists of graphs of key macroeconomic series over the period 1967-97. Annex B defines the variables used in the model and lists the data sources. Annex C presents a brief overview of macroeconomic policy models. Annex D suggests how the econometric model can be embedded in a financial programming framework.

2. Historical Background

There is now a rich literature on the Zambian economy[2]. Contributions up to the mid-1970s tended to focus on the factors responsible for Zambia's economic progress and how to deal with challenges faced by the government as it sought to foster economic development by extending its control over the economy. From the mid-1970s onwards, the emphasis shifted to the policies and actions needed to arrest and reverse Zambia's economic decline. From the mid-1980s, most analyses have highlighted the changes needed to promote structural adjustment and economic reform.

The broad economic trends in Zambia over the last three decades can be measured in a variety of ways. It is convenient to use the readily available data bases of the World Bank, International Monetary Fund (IMF) and the United Nations Development Programme[3]. These data are a rich and reliable source of historical and current information[4]. Although some biases and errors are inevitable[5], the underlying trends fully reflect the economy's performance.

In Zambia's case, the data show that the economy has become highly indebted, had rapid inflation, experienced a sharp decline in copper production, had erratic agricultural output, and recorded no substantial increase in formal sector employment for more than two decades. The data, however, do not reveal the widespread shift of economic activity into informal channels as individuals and businesses sought ways of protecting themselves from the distortions created by state intervention. The data also do not reveal the resources transferred from Zambia through capital flight[6] or the potential investment that was discouraged from flowing to Zambia because of counterproductive government policies.

Annex A presents several major macroeconomic trends in Zambia since 1970. Figure 1 graphs the path of the real GDP per capita. It shows that there has been no sustained increase in real income since the early 1970s. With population growth of around 3 percent per annum, real per capita income is now at around 55 percent its level of twenty-five years ago[7]. Figure 2 plots the annual rate of inflation. Inflation accelerated sharply around 1988. This coincided with the government's program of "growth from own resources"[8]. Inflation accelerated because Zambia's "own resources" were limited. Figure 3 shows that as inflation rose the Kwacha depreciated sharply. By contrast, the real exchange rate, shown in Figure 4, has tended to appreciate since 1988. The rate of depreciation of the nominal exchange rate, though large, has not compensated for the rate of domestic inflation. Zambia's international competitiveness has suffered[9]. The appreciation of the real exchange rate also explains why Zambia has continued to run large balance of payments deficits. The implication is that the Zambian economy has still not adjusted in a positive way to the sharp decline in *national* productivity due to the decline in the copper industry from mid 1970s onwards[10]. It has, however, adjusted negatively through the continued collapse in real income[11].

Figures 5 and 6, respectively, show the annual changes (in real terms) in mining and agricultural production. Both series have been unstable. In per capita terms, both copper production and agricultural output have declined sharply.

Figure 7 traces foreign aid flows over time. The increase during the 1990s reflects the surge in aid accompanying the return to multi-party democracy. The blip in 1995 was the result of the completion of the IMF's Rights Accumulation Program (RAP)[12]. This program gave Zambia access to IMF funding through an ESAF arrangement that allowed Zambia to retire its arrears to the Fund[13]. It is illuminating to juxtapose the rise in foreign aid since the mid-1970s against Zambia's growth performance (Figure 1). When Zambia was an international creditor, it grew. As an aid recipient, Zambia has regressed[14].

Figure 8 plots the annual changes in broad money. Many of Zambia's economic troubles (rapid inflation, declining income, excessive debt, and macroeconomic instability) are reflected in the movements of this series. The growth of broad money is directly linked to changes in reserve money which is a key policy variable. When reserve money is not properly controlled major economic damage ensues[15].

Figure 9 highlights the principal "cause" of the rapid growth of reserve money, namely budget deficits. They have been large since 1975. In some years the deficit exceeded 20 percent of GDP (1975, 1986 and 1991.) Persistent deficits have only one cause - irresponsible macroeconomic management.

Figure 10 shows the increase in Zambia's external debt. Support from the international community of almost $6 billion since 1992 has made little impression on the debt stock. The problem is that Zambia continues to run a large deficit on the current account of the balance of payments[16]. While this deficit continues, Zambia's debt problem cannot be resolved despite debt write-offs, write-downs, and debt forgiveness.

The last two figures (11 and 12) are, respectively, the copper price and maize price in international markets. Both are in nominal terms. Adjusting them for inflation would show that both series have declined. These trends are indicative of broader movements in other resource prices. Due to technical innovation and shifting patterns of demand and supply, the upward trend in the real price of all commodities evident in the 1970s has been reversed. Zambia has directly lost real income through the decline in copper prices. The severity of the terms of trade "shock" has been substantially modified by sharp changes in other prices[17].

These data summarize Zambia's major macroeconomic problems. These are: stagnating real per capita income, large budget deficits, rapid monetary growth, chronic balance of payments deficits, declining per capita real output in the mines and agriculture, high rates of inflation, and an appreciating real exchange rate. None of the major trends has been favorable. Improvement, when it occurs, has usually been sporadic and, to this point, has never been sustained. Even the positive effects of the recent decline in the budget deficit have been dampened by the negative effects of a large balance of payments deficit, the sharp increase in external debt due to ZCCM's losses and the liquidity crunch due to the build up in ZCCM's arrears[18]. Similarly, while Zambia's inflation has fallen over the past two years, world inflation has fallen even faster[19].

The main question facing Zambia is how to move forward despite these many constraints. The results of the econometric model provide us with a better appreciation of the inter-connections within the economy. From this we can highlight some of the potential changes that will help promote and sustain growth and development.

3. The Model

a. Why a Model?

Economic modeling is a rich field of study. Many models of the Zambian economy have now been constructed. One of the first was the "modified input-output" framework constructed by Dudley Seers to complement the work of the UN/ECA/FAO mission to Zambia in 1964. A number of scholars have taken advantage of the excellent set of input-output tables produced in Zambia from 1969 onwards. One noteworthy effort was the dynamic simulation model of Charles Blitzer. This model was a precursor to Computable General Equilibrium (CGE) models[20]. A group sponsored by the European Union has been working for some years to construct a CGE model for Zambia[21]. Other efforts have involved simulation techniques and input-output analysis[22]. Finally, as longer time series have been assembled, models have sought to combine econometric estimation with input-output techniques[23].

With so many models available, there is no need to build a model of the Zambia economy from "scratch". Indeed, the model discussed below has been adapted from a well-known equation system[24]. Though small and simple, this model is tractable and relevant. One of its advantages, discussed further in section 4, is that it can be directly linked to the standard financial programming framework used by the IMF.

But, why bother with an econometric model? Aren't the main linkages in the Zambian economy obvious? Moreover, hasn't the performance of the last two decades been so uncharacteristic of Zambia's potential that a formal model cannot yield sensible results? These questions can be answered in several ways.

Much can be learned about an economy without a formal model. Yet, intuition and casual inspection of data series do not reveal either the strength or direction of the various inter-connections. Statistical estimation of these relations adds another dimension to the analysis. Indeed, formal statistical analysis is the only way to determine the various partial correlations, lead-lag relationships, causality, simultaneity, and feedback among the relevant variables. There are so many inter-connections associated with the behavior of individuals and firms that a formal model is required if only to retain consistency and coherence in the analysis. Some of the choices, which support this behavior include:

- consumers and producers always face varying opportunities for substitution (both directly and indirectly) among products, factors and services;
- there are transaction costs and market "frictions" (much as agency costs and menu costs), which consumers and producers encounter as they exercise their respective market or portfolio choices;
- competitive pressures differ across sectors and markets;
- asymmetries exist in the access to information by consumers and producers and their ability to interpret this information;
- the impact of government interventions vary across different groups;
- consumers and producers have different attitudes to risk; and,
- potential rewards of market search differ across consumer and producer groups.

Other considerations are relevant as well. All economic systems experience positive and negative shocks that reverberate at different rates across sectors and among individuals and firms. Public goods influence the ability of different groups to engage in welfare-enhancing and productive activities. Wide differences exist in the efficiency, prudence and effectiveness with which governments manage the economy. Finally, all economies have links of differing intensity and direction to the world economy. These links, in turn, have their own sets of "knock-on" and "spillover" effects within the domestic economy[25].

While many of these theoretical points highlight the potential value of using a model, the main practical consideration is whether the estimated model can provide any policy relevant results. There are two issues. First, in a developing country such as Zambia, which has undergone severe economic disruption, the analysed model can be ill-conditioned. Small changes in its specification or lag structure can lead to large changes in the size and direction of key parameters. These, in turn, destabilize the projection results. An ill-conditioned model mirrors the underlying economic conditions. If these have been unstable over time, mainly due to lack of consistency and coherence in economic policy and management[26], the model's results will need to be interpreted with caution. Yet, some of the ill-conditioned or inverted relations in the model can point to the need for specific types of policy reforms. These can help move an economy in the appropriate direction.

Second, in Zambia (as in many other developing countries), prices, exchange rates and interest rates were controlled for much of the period being examined (1967 to 1997). These controls imposed rigidities on the economy and tended to produce some theoretically unexpected associations. Yet, these considerations do not invalidate the use of simultaneous equations model such as the one we have specified. Such a model is a useful way of capturing (and attempting to measure) the consequences of the controls via the "spillover" effects on the variables that have not been controlled. This is also one way of tracing the (often perverse) trends in the government budget deficit, balance of payments deficit, growth of money supply, flows of foreign assistance, changes in imports and increase in external debt. Due to the effects of controls, some of the important relationships run contrary to theory. While these results are disturbing, they cannot be rejected outright. The model imposes consistency on the overall system so that its results incorporate all the various interactions. The value of these results is that they highlight the types of changes needed to reform the economy and return it to a stable, sustainable, growth trajectory.

b. Specification of the Model[27]

In constructing the model, we treat Zambia as a small, open developing country, which is exposed to world market fluctuations. The estimated model consists of seven behavioral equations and three accounting identities. Despite its simple structure, this model highlights some important features of the Zambian economy. In specifying the equations, we have combined theory and institutional considerations[28]. The final version of each equation reported here was reached after some empirical experimentation and re-calibration of the system. In the process of developing the model, many variables and different lag structures proved to have no statistically significant effect and were dropped.

Using the definitions given in Annex B, the model consists of the following equations:

1. Inflation

$$\Delta p_t = f_1 [\, \Delta yr_t, \Delta m_t, \Delta e_t, \Delta p_t^f, \Delta p_{t-1} \,]$$

2. Real Income

$$\Delta yr_t = f_2 [\, \Delta er_t, \Delta p_t, \Delta min_t, \Delta agr_t, \Delta aid_t \,]$$

3. Change in Exchange Rate

$$\Delta e_t = f_3 [\, \Delta m_{t-1}, \Delta p_{t-1}, \Delta i_t, \Delta aid_t \,]$$

4. Government Revenue

$$t_t = f_4 [\, y_t, min_t, im_t, aid_t, p_t^{copper} \,]$$

5. Imports

$$im_t = f_5 [\, y_t, e_t, aid_{t-1}, im_{t-1} \,]$$

6. Growth in Agricultural Production

$$\Delta agr_t = f_6 [\, \Delta yr_t, \Delta er_{t-1}, \Delta p_{t-1}^{maize}, rain_t \,]$$

7. Growth in Mining Production

$$\Delta min_t = f_7 [\, \Delta yr_t, \Delta er_{t-1}, \Delta im_t, \Delta p_{t-1}^{copper} \,]$$

8. Money Supply

$$\Delta M^S_t = \Delta DC_t + \Delta NFA_t$$

9. Balance of Payments

$$\Delta NFA_t = EX_t - IM_t + CAP_t + AID_t$$

10. Domestic Credit

$$\Delta DC_t = G_t - T_t + \Delta CP_t$$

Inflation: The inflation rate equation relates the rate of change in the domestic price level to the increase in money supply, the growth of real GDP, the change in the nominal exchange rate, the change in foreign prices, and the lagged inflation rate. These variables are consistent with the standard approach to the demand for money. (The inflation equation is an inverted money demand equation.) The addition of foreign prices, approximated by the U.S. consumer price level, and the exchange rate help measure the influence of external events on domestic prices.

Growth of Real Income: The growth of real income depends on the changes in the real exchange rate and inflation, the growth of output in mining and agriculture, and the changes in foreign aid. The equation is a composite of theory and structural variables. In theory, the growth of real income should be related to the growth of factors of production (labor and capital) and variables which capture changes in factor productivity (technology, information, and organization). Some theories also link income growth and the growth of money supply. We tried this relationship without success. Movements in the exchange rate reflect comparative advantage and, indirectly, productivity. Finally, the inclusion of foreign aid is an attempt to measure the degree to which aid might compensate for the decline in real income.

Change in Exchange Rate: The nominal exchange rate equation includes the changes in the money supply, a measure of expected inflation, the change in domestic interest rates, and foreign aid. Apart from foreign aid, which tends to appreciate the exchange rate[29], the other variables are consistent with standard treatments of exchange rate determination derived from purchasing power parity, interest rate parity, and the monetary theory of the balance of payments. The income variable proved to be statistically insignificant and was excluded from the final version of the equation. The correct term for interest rates should be some measure of the differential between domestic and foreign interest rates. The former were so large and movements so sharp, that they dominated the relation. The intention, however, is to capture the portfolio effects of changing inducements to hold local assets.

Government Revenue: Government revenue is related to the main elements of the tax base – aggregate economic activity, mining production, and imports. Copper prices enter the equation as an index of shifts in the export tax base. Aid flows are included for two reasons. Aid adds to total

expenditure thereby contributing indirectly to the revenue. Aid also tends to change (mainly reduce) the incentive for the government to raise resources domestically[30].

Imports: Imports are related to income, the exchange rate, lagged aid flows, and lagged imports. Income is a measure of demand, exchange rates measure the relative costs of importables, and aid is a measure of the extent to which foreign assistance helps overcome impediments to imports by easing the foreign exchange constraint. (We had included exports to capture the same effect. Its impact was statistically insignificant.) The inclusion of lagged imports is an attempt to measure the delays due to Zambia's distance from major trading centers[31].

Growth in Agriculture: The growth in agricultural output is related to real output growth, the changes in the real exchange rate, the changes in the foreign price of maize, and a variable accounting for the amount of rainfall. Aid flows were initially included because of the long history of foreign support to Zambian agriculture. They were statistically insignificant.

Growth in Mining Production: The growth of mining output depends upon the growth of aggregate real income, the real exchange rate, imports, and the changes in copper prices. Real income variable is meant to capture the linkages of mining to the rest of the economy. The real exchange rate reflects the movements in productivity in Zambia relative to the rest of the world. Imports are included in recognition of the mining sector's crucial dependence on key imports, such as machinery, equipment, fuel and spare parts. The copper price is intended to measure shifts in the relative profitability of mining.

The Identities: The identities impose limits and consistency on the variables of the model and insure the identification of the system of equations. The change in money supply is the sum of the change in the net foreign assets and change in net domestic credit. The balance of payments (reflected in the change in net foreign assets of the banking system) is the sum of the trade balance and capital flows including aid. Domestic credit consists of its public and private components. The former highlights the impact of changes in domestic credit due to the financing of the budget.

c. Issues Related to Model Estimation

Statistical methods for systems of simultaneous equations capture the mutual dependence among the variables in the model[32]. Techniques in which equations are estimated one at a time are called limited information methods. Full information methods are those where all equations are estimated at the same time. Limited information methods do not take into account connections among variables from different equations within the system. Full information methods allow for these connections. Since all available information is incorporated, this produces more efficient parameter estimation. The Three Stages Least Squares (3SLS) method used in this paper is a full information method.

Variables in the system are categorized as endogenous (those explained within the model) and exogenous (those determined outside the model.) Simultaneity within the model arises because some endogenous variables appear as explanatory variables in other equations. The set of

exogenous variables often includes lagged values of the explanatory variables. These "predetermined" variables impose the dynamic structure on the model.

"Identifying" restrictions are required in any simultaneous systems technique. These restrictions, which typically involve the exclusion of variables from some equations, enable the parameters of the model to be derived uniquely. With too few restrictions the parameter estimates are indeterminate. The simplest identifying restriction is the "order" condition which requires that the number of exogenous variables excluded from an equation is at least as large as the number of endogenous variables included in that equation.

Simultaneous equation methods have several well-known limitations. The classification of variables as exogenous or endogenous is subjective. The restrictions used to identify the parameters can lead to the exclusion of relevant variables from some equations. The system parameters are assumed to be independent of changes that would make them subject to the Lucas critique[33]. Finally, in order to be tractable, the systems have to be relatively simple. Otherwise, they take on the features of a "black box".

d. The Estimation Results

The 3SLS estimates of the parameters of the model are as follows:

Dependent Variable: Inflation Rate

Variable	Coefficient	Std. Error	t-Statistics
Constant	-0.05	0.09	-0.63
Δyr_t	0.65	0.73	0.89
Δm_t	0.44	0.19	2.26
Δe_t	0.27	0.09	3.20
Δp_t^f	0.61	1.07	0.57
Δp_{t-1}	0.40	0.14	2.80

Dependent Variable: Real Income Growth

Variable	Coefficient	Std. Error	t-Statistics
Constant	0.02	0.01	3.03
Δer_t	-0.02	0.02	-0.95
Δp_t	-0.01	0.02	-0.49
Δmin_t	0.18	0.07	2.52
Δagr_t	0.18	0.05	3.96
Δaid_t	-0.02	0.01	-1.34

Dependent Variable: Change in Exchange Rate

Variable	Coefficient	Std. Error	t-Statistics
Constant	-0.01	0.11	-0.08
Δm_{t-1}	0.51	0.50	1.01

Δp_{t-1}	0.24	0.38	0.61
Δi_t	0.56	0.19	2.92
Δaid_t	0.14	0.15	0.89

Dependent Variable: Government Revenue

Variable	Coefficient	Std. Error	t-Statistics
Constant	-5.12	2.33	-2.20
y_t	0.38	0.16	2.45
im_t	0.60	0.17	3.64
aid_t	-0.09	0.04	-2.27
min_t	0.53	0.47	1.13
p_t^{copper}	0.28	0.13	2.09

Dependent Variable: Imports

Variable	Coefficient	Std. Error	t-Statistics
Constant	-1.92	0.94	-2.03
y_t	0.38	0.16	2.32
e_t	0.23	0.09	2.59
aid_{t-1}	0.03	0.04	0.70
im_{t-1}	0.38	0.11	3.34

Dependent Variable: Growth in Agricultural Production

Variable	Coefficient	Std. Error	t-Statistics	
Constant	-0.02	0.04	-0.41	Δyr_t
1.84	0.58	3.16		
Δer_{t-1}	-0.02	0.08	-0.21	
Δp_{t-1}^{maize}	-0.003	0.11	-0.03	
$rain_t$	-0.003	0.01	-0.50	

Dependent Variable: Growth in Mining Production

Variable	Coefficient	Std. Error	t-Statistics	
Constant	-0.02	0.02	-1.13	Δyr_t
1.04	0.42	2.46		
Δer_{t-1}	0.06	0.06	1.11	
Δim_t	-0.03	0.05	-0.55	
Δp_{t-1}^{copper}	-0.02	0.07	-0.27	

As the estimation results show, inflation is significantly related to the changes in broad money and the nominal exchange rate, and to the lagged inflation (as a proxy for the inflationary expectations.) It is marginally related to the real income but with the incorrect sign. Foreign

inflation, approximated by the changes in the U.S. CPI, has not had a direct significant effect on Zambian inflation.

The growth of real income is highly dependent on changes in agricultural output and mining production. Income growth is negatively and modestly related to changes in aid flows. Given that Zambia has received around 15 percent of GDP in foreign assistance for the last decade and a half, the *a priori* expectation is that this relationship would be positive and highly significant. The opposite result supports the growing evidence that aid has been counterproductive in Zambia, a finding that is emerging for other developing countries as well[34]. The lack of any significant statistical relationship between real income growth and the changes in the real exchange rate is contrary to expectations. Real exchange rate depreciation is supposed to promote growth, yet in all specifications of this equation that we tested, the sign and the significance of the real exchange rate didn't change. There are two explanations. First, the effect of the real exchange rate on growth is typically indirect. Second, there has been so much disruption over the period being examined, in the form of controls on the official exchange rate, currency substitution, capital flight, parallel markets, and massive flows of external funds (both loans and aid), that any direct relation between the real exchange rate and income growth may have been overwhelmed by other factors.

In the exchange rate equation changes in money supply (with one lag) have the expected positive effect. That effect, however, is statistically insignificant. Neither the lagged nor the contemporaneous value of the changes in domestic prices has a statistically significant impact. Aid flows are weakly related to the movements in the exchange rate. The positive sign of the coefficient is consistent with the fact that aid typically increases in periods of balance of payments difficulties. A common condition for receiving aid is realignment of the exchange rate. Interest rate movements have a positive and significant effect on the exchange rate (this result was present in all specifications of the exchange rate equation that we tested.) This, too, is contrary to expectations. Raising interest rates should lead to an appreciation of the exchange rate[35]. They might have lowered the rate of depreciation, which could account for the observed relationship.

Government revenue is significantly related to income, imports and the copper price. These are all elements of the tax base. The estimated coefficient on foreign aid is negative and significant. This result supports the hypothesis that the availability of foreign assistance diminishes the pressure on the government to raise revenue.

Imports are positively related to nominal income and the exchange rate. The latter result is contrary to theoretical predictions. The implication is that depreciation of the exchange rate leads to an increase in imports. A possible explanation is that the economic disruption over the last two decades has led to significant import compression. Devaluation is prompted by or associated with an increase in foreign assistance, which then leads to an increase in imports. The direct effect of aid on imports, however, is positive but not statistically significant.

The results of the equations for the change in agricultural and mining production are noteworthy for their general lack of association with other key variables. They both show a strong connection to real income growth. This reflects the simultaneity referred to earlier. The effect of the changes

in real exchange rate in both equations is insignificant. We also tested the direct link between agricultural and mining production, and the world market price (with one lag) of maize and copper, respectively. The estimated coefficients of the two price variables are not significant. The rainfall variable (defined as the absolute deviation from the mean quantity of rainfall over the sample period) has the correct negative sign, but the coefficient is statistically negligible.

4. Projection Results and Possible Extensions of the Model

a. Projections

Using the estimated system of equations above, we calculate the projected values of the endogenous variables for 1998 and 1999. These are intended to provide some general guidance about the coherence of the model and its structural parameters. In practice, the model we have estimated will not support long-term projections. A typical approach would be to regularly re-estimate (and perhaps re-specify) the model as new data become available.

We have calculated the projections by pre-setting future values for the exogenous variables. These are based on the emerging estimates for 1998 and the assumptions used in the 1998 Budget Speech for 1999. The specific values are given in Annex 2.

With these values of the exogenous variables, the forecast for 1998 and 1999 for the inflation rate, real income growth, agricultural and mining production growth, the change in exchange rate and the levels of government revenue and imports follow.

Year	Inflation	Real Income Growth	Change in Exchange Rate	Imports (bill. Kwacha)
1998	32.9	1.2	57.2	3158.2
1999	38.7	1.4	62.2	4877.5

Year	Agricultural Production Growth	Mining Production Growth	Government Revenue (bill. Kwacha)
1998	-1.9	-0.3	1408.4
1999	-1.6	1.0	1856.1

The projected values for the inflation rate and real GDP growth are close to the estimated outcome for 1998 (29.3% and –2.0% respectively) recently provided in a report at a national economic forum in Lusaka. Compared to the analysis in this report, our model underestimates the decline in agricultural production (in real terms): -1.9% versus an estimated decline of 6.1%; and the decline in mining production: projected -1.6% versus estimated -11.0%. Part of the explanation for the discrepancy in the outcome for the mining sector is that the tremendous fall in its production was due mainly to the uncertainty surrounding the future of ZCCM and the institutional impediments to its privatization that cannot be accounted for in the model. ZCCM's

massive losses and the withdrawal of investment due to the low state of confidence will continue to affect adversely the Zambian economy well into 1999.

The nominal exchange rate is predicted to increase by more than 57 percent in 1998 (amounting to a real devaluation of 27 percent) and the Kwacha price of the US Dollar will approach 2300. These numbers are consistent with recent government estimates. The projections for imports and government revenue are also consistent with the preliminary numbers for 1998.

Considering the recent economic developments in Zambia, the projections for 1999 may seem far-stretched. Nevertheless, they are indicative of a possible economic path if structural and policy changes don't take place.

None of the projections is especially optimistic. They show that the economy will continue to decline. This outcome, however, is fully consistent with government's overall unwillingness to vigorously press forward with economic reform.

b. Possible Extensions of the Model

The model could be extended in a number of ways. The existing system of equations could be specified in a greater detail by adding exogenous and endogenous variables. Or, the model could be directly linked to the financial programming framework so as to provide policy relevant projections (Annex C explains policy modeling in more detail.)

In specifying the model, we have glossed over issues of productivity improvements, which provide the basis for long-term increases in real per capita income. This would require some detailed attention to sectoral production relations and trends in unit labor costs. The exchange rate equation could be improved (or made more relevant) by adding the foreign exchange premium. More detail in the government revenue equation would allow policy makers to focus on particular components of the tax base.

Adding endogenous variables would expand the equation system and enhance its explanatory power. Obvious examples are an investment equation, a labor demand equation, specific price equations (e.g. for maize), output equations for other important sectors (e.g., manufacturing), an asset demand equation, an interest rate relation, and an equation for non-traditional exports. Estimating these relations depends on data availability.

A third modification would be to connect the econometric model with the financial programming analysis undertaken as part of IMF/World Bank efforts in support of structural adjustment (Annex D has a note on financial programming.) The model has several evident links already. Some of the key elements of the financial programming exercise, such as inflation, real output, and the exchange rate, are dependent variables in the model. Short-term projections of these variables using the model provide a consistent framework for the projections upon which the financial programming exercise is based.

5. Concluding Comments

This paper provides a tractable, policy-relevant model of the Zambian economy. The value of such a model for policy makers and their advisors is that it provides a framework for systematical examination of the principal economic relationships in the economy, their direction and significance.

The data used in the model were comprehensive and the full-information estimation technique (3SLS) provides a simple way of deriving the parameter estimates. Apart from some of the counter-intuitive relations - largely a result of government controls and distortions created by large aid flows - few of the results are surprising. Over the period considered - 1967 to 1997 - very little happened on the real side of the economy. Output declined and the economy lacked dynamism. On the monetary side, asset-holders have been responding in a predictable way to the massive expansion of domestic credit to finance the budget deficit. They have substituted away from local financial assets. Inflation, which had earlier been dampened by large-scale foreign borrowing gained momentum. Much of the subsequent economic damage stemmed from the consequences of monetary mismanagement.

There are several policy implications evident in the results. Zambia has little chance of returning to a path of rapid, sustained growth and development without fundamental changes that eliminate the budget deficit and sharply depreciate the real exchange rate. A major effort is required to enhance productivity[36]. Some changes may be heading the economy in that direction. The recent trend in the budget deficit is encouraging. The overall moderation of monetary growth is another positive development. There is a major need for agriculture and mining sectors to grow. The government should also consider measures that would provide Zambia with an “aid exit” strategy. Such a medium term initiative would focus attention of all the appropriate changes needed to generate more investable resources locally. None of these steps is occurring at the rate required to make a fundamental difference to Zambia’s prospects for rapid growth and development.

The challenge for policy is to recognize the need for these changes and act boldly. At the present rate, Zambia is dawdling towards the twenty-first century with prospects little changed from what they have been over the last twenty-five years. Zambia has regressed for long enough. Rapid progress spurred by sustained broad-based policy reform is long overdue.

Annex A: Basic Trends in the Data

Fig.1 Real GDP per capita (in Kwacha, 1990 prices)

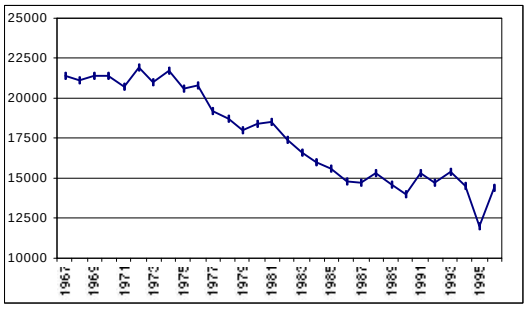


Fig.2 Inflation Rate (percentage change in CPI)

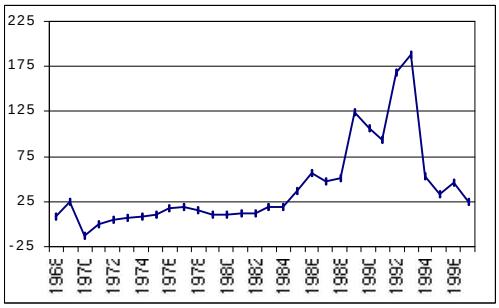


Fig.3 Exchange Rate (in logarithms) Kwacha per US Dollar

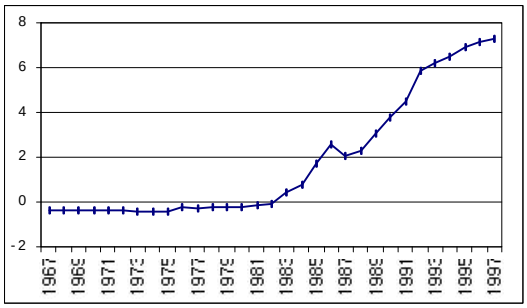


Fig.4 Real Exchange Rate (in logarithms) Kwacha per US Dollar

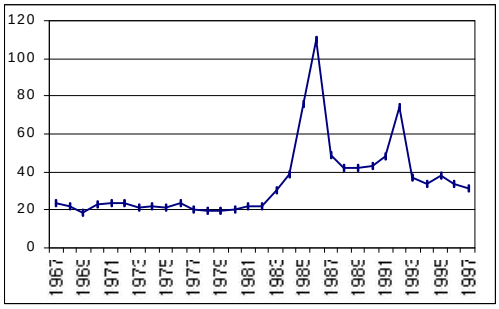


Fig.5 Mining Production Index (1990=100) percentage change

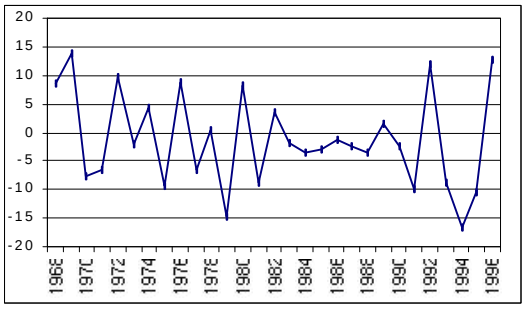


Fig.6 Agricultural Production Index (1990=100) percentage change

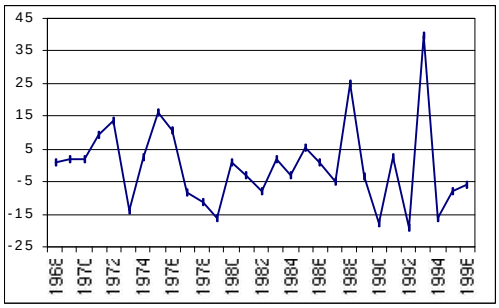


Fig.7 Foreign Aid (percentage of GDP)

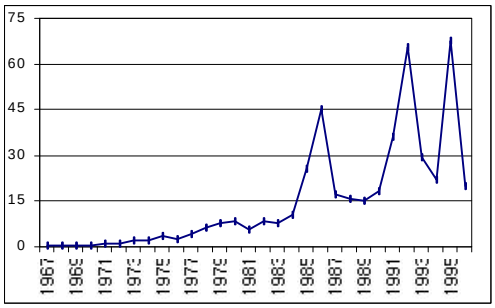


Fig.8 Broad Money (percentage change)

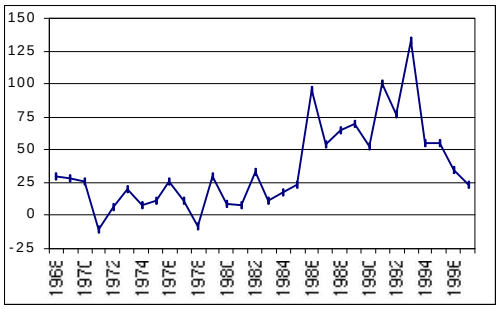


Fig.9 Budget Deficit (percentage of GDP) including Grants

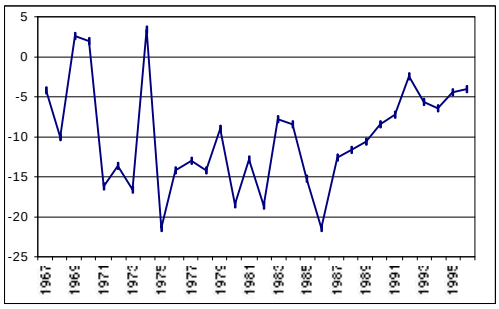


Fig.10 External Debt, total (billions of USD)

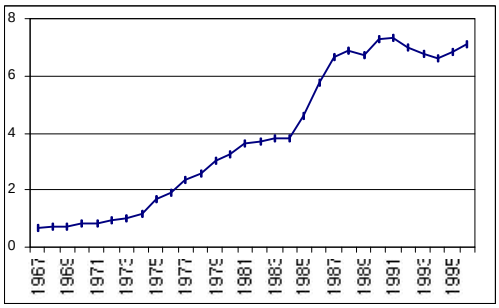


Fig.11 Copper Prices (US Dollars per pound)

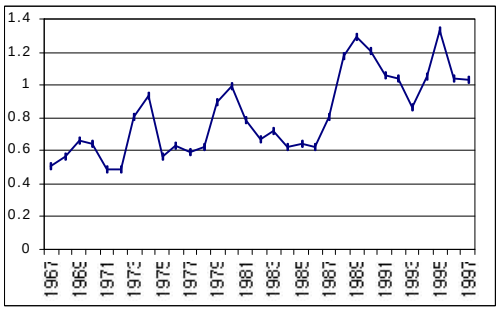
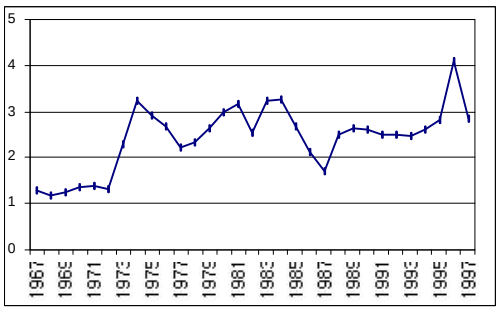


Fig.12 Maize Prices (US Dollar per bushel)



Annex B: Definition of Variables and Sources of Data

Δp_t - rate of inflation (based on the CPI, 1990=100)
Δp_{t-1} - a proxy for the expected inflation rate at time **t**
Δp_t^f - a proxy for foreign rate of inflation (based on the U.S. CPI, 1990=100)
Δy_t - growth rate of nominal GDP
Δyr_t - growth rate of real GDP (1990 prices)
Δagr_t - change in agricultural production index (1990=100)
Δmin_t - change in mining production index (1990=100)
Δi_t - change in domestic nominal interest rate (Treasury Bill Rate, percent per annum)
Δe_t - change in nominal exchange rate (in units of domestic currency per U.S. Dollar)
Δer_t - change in real exchange rate (nominal exchange rate adjusted for domestic and foreign prices)
Δm_t - change in nominal stock of money (Money plus Quasi-Money)
P_t^{copper} - world market price of copper (U.K., London, U.S. Dollars per pound)
P_t^{maize} - world market price of maize (U.S., Chicago, U.S Dollars per bushel)
IM_t - imports of goods and non-factor services (in billions of Kwacha)
EX_t - exports of goods and non-factor services (in billions of Kwacha)
G_t - government expenditure (in billions of Kwacha)
T_t - government revenue (in billions of Kwacha)
AID_t - foreign aid flows (in billions of U.S. Dollars)
NFA_t - net foreign assets (in billions of Kwacha)
DC_t - domestic credit (in billions of Kwacha)
CP_t - claims of the banking system on the domestic private sector (in billions of Kwacha)
CAP_t - capital flows
$DEBT_t$ - external debt (in billions of U.S. Dollars)
$RAIN_t$ - weather variable, defined as the absolute deviation from the mean rainfall in inches over 1967-97 in the region of Momba farms and Green's farm.

Note:
Lower-case letter denotes the logarithm of the upper-case variable.

Sources:
1) International Financial Statistics, Yearbook 1998; December 1998, IMF.
2) Zambia - Selected Issues and Statistical Appendix, IMF Staff Country Report, November 1997, IMF.
3) World Development Indicators, 1998, World Bank.
4) Macroeconomic Indicators, Ministry of Finance and Economic Development, Zambia, various issues.

Assumptions for the Projections

Growth of nominal money of 30 percent per annum;
Growth of Credit to the Private Sector of 30 percent per annum;
Decrease in Exports of 29 percent;
Change in Government Expenditure of 4 percent;
Increase in nominal Interest Rate of 115 percent;
Foreign Inflation of 2.5 percent;
Decrease in world market copper prices of 41 percent;
Decrease in world market maize prices of 10 percent;
Decrease in Foreign Aid by 5 percent.
As a proxy for the value of the Rainfall variable we use its value from the previous period.

Annex C: Policy Models

Policy models are specified in ways that highlight the linkages between the "policy instruments" and "targets". The former are variables over which the authorities (the government or central bank) have some control in the short to medium term. Examples are tax rates, interest rates on government bonds, the growth of reserve money, and the level of public expenditure on capital projects.

Policy targets are the specific economic variables that the authorities wish to influence. They may include the rate of growth of real income per capita, the rate of inflation, the accumulation of foreign reserves, or the trend path of the exchange rate. The choice of targets and instruments depends on the government's philosophy of development. Governments that see their role as "taking the lead" in promoting development will tend to fix a variety of variables in anticipation that the economy will adjust in ways that justify their original policy actions. By contrast, governments that view their role as facilitating the creation of a setting in which private enterprise can flourish will not attempt to control any specific variables. They will seek to influence economic outcomes by indirect means such as the expansion of infrastructure and the enhancement in market incentives.

The general "policy" problem is to determine the changes in the instruments which, given the overall structure of the economy as reflected in the economic model, will have the desired effect on the targets[37]. For example, a central bank wishing to maintain a stable exchange rate has two options. The first is to fix the official exchange rate within a specific "band" and then supply whatever foreign exchange is demanded. The second is to allow the exchange rate to be market-determined but to change interest rates, the growth of reserve money, and the trend path of foreign exchange reserves in ways that counteract any sharp movements of the exchange rate away from a desired level. In both cases, the central bank's "success" in targeting the exchange rate will depend on its influence on the other relevant variables and how the remainder of the economy responds to these changes.

Thus, the basic "policy modeling" problem is relatively straightforward. An economic model is specified, the "targets" are designated, and the "instruments" are chosen. The model is estimated and then solved to determine the range over which the instruments have to be manipulated to achieve the desired changes in the targets.

Despite its apparent simplicity, some important formal requirements constrain how a model can be specified and used. One requirement is "consistency". There has to be at least one instrument for each target. A second requirement is "efficiency" in the choice of instruments[38]. The idea is to relate instruments as directly as possible to the targets. For example, an efficient way of dealing with a balance of payments problem is to change the exchange rate. A less efficient way is to impose wage controls in the hope that the reduction in income will curtail the demand for imports sufficiently to ease the pressure on the balance of payments.

Two other constraints should be noted. The first is "Goodhart's Law" which asserts that variables used as instruments progressively lose their relevance[39]. This occurs because of changes in the behavior of those most directly affected by the policy instrument. Monetary policy provides an example. According to monetarist doctrine, a stable relation exists between the growth of money supply and the growth of nominal income. By controlling the supply of money, central banks can control the growth of nominal income thereby stabilizing the economy. Based on this doctrine, many central banks began setting specific money growth targets. Over time, financial innovation made it more difficult to define a relevant money supply variable that the central bank could control. Measures of velocity (the ratio of income to money) became increasingly unstable, leading central banks to abandon money supply as an instrument.

The second constraint is the "Lucas critique"[40]. Economic policy, by its nature, seeks to change economic relationships (e.g., induce individuals and firms to produce more, save more, invest more, consume less, and so on.) Thus, policy responses cannot be accurately predicted by a model when that policy has been designed to modify the structure of the economy. In principle, there is no formal way around this indeterminacy[41].

Yet, in practice, Goodhart's Law and the Lucas critique do not negate modeling exercises. Variables do not immediately lose their relevance once they are used as an instrument and economic structures do not change so dramatically that the effects of policy changes become unpredictable. A practical response to these constraints is for analysts to view their economic models as iterative, path-dependent structures that require regular revision and re-calibration.

A final point is that because an economy is a dynamic interdependent system, the decision not to change a particular policy also has important economic repercussions. By doing nothing, policy makers implicitly expect the dynamic interactions within the economy to continue producing acceptable policy outcomes. Under the particular circumstances, doing nothing may be the appropriate policy choice. However, in making this choice policy makers should consider three questions. What impact will the choice (to do nothing) have on public confidence in the economy? Will this decision keep open existing options for the future (or even expand them)? Does the choice to do nothing impose avoidable adjustment costs that are not offset by compensating benefits elsewhere in the economy? (The same questions apply if the policy choice produces some tangible change in the various policy instruments.)

Annex D: A Note on Financial Programming[42]

The financial programming framework begins with a projection of nominal GDP. A value of velocity is derived usually from recent experience. This provides an estimate of the growth in the money supply over the program period. Based on the components of the balance of payments - exports, imports, debt service payments, and aid flows - an estimate is obtained for the change in the net foreign assets of the banking system. Together with the change in the money supply (calculated using the velocity relation), this estimate allows the change in net domestic credit to be derived. The change in net domestic credit is then divided into its public and private sector components. Since a major objective of structural adjustment is to "make more room for the private sector" the IMF typically allows a generous increase in net credit to the private sector. The residual provides an upper bound on the potential increase in net credit to the government.

Using data from the projected revenues and expenditures by government and the anticipated flows of foreign resources (grants and loans), a preliminary estimate of the budget deficit that has to be funded locally is derived. The projected amount of non-bank financing is subtracted from this estimate. The result is the projected change in the net credit to government from the banking system. If the estimate is below the upper bound of this variable derived earlier, no further adjustment to the budget is required. If not, additional ways of raising revenue and cutting expenditure have to be found for the financial program to be consistent.

The main advantage of this approach is that it is systematic and consistent. All of the accounts have to add up. It is also a relatively simple way of compressing many complex interactions into a tractable framework that can be analyzed using a spreadsheet.

The disadvantage of the approach is that the estimates only hold over the very short term. Here the Lucas critique is relevant. Countries undergoing structural adjustment specifically implement policies that are intended to transform the structure of their economy. Because financial markets adjust rapidly, the relationships between the variables in the financial program can change significantly. A further disadvantage is that the financial program has no behavioral relations. The velocity variable is assumed. The real rate of growth and rate of inflation, which together comprise the initial projection of nominal GDP, are both assumed. The projected movements of the exchange rate are usually derived by assuming that purchasing power parity (PPP) holds. An important objective of structural adjustment is to achieve a sustained depreciation of the real exchange rate. But, by assuming that PPP holds, the financial program understates the desired rate of exchange rate depreciation. Further problems are that there is no feedback from the controls on monetary variables to domestic interest rates. Finally, the financial program makes no allowance for the spillover effects of aid flows, particular when these are a large component of resources flows.

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ENDNOTES

[1] Research supported by USAID under the Equity and Growth through Economic Research (EAGER/Public Strategies for Growth with Equity) project is being conducted on the topic "Restarting and Sustaining Growth and Development in Africa". Country studies are underway in Tanzania, Uganda, Kenya, Ghana and Senegal.

[2] Some of the scholarly work includes Baldwin (1965), ILO (1969), de Gaay Fortman (1969), Faber and Potter (1971), Bostock and Elliott (1972), Martin (1972), Harvey (1972), Bates (1974), Seidman (1974), Sklar (1975), Markakis and Curry (1976), Dodge (1977), McPherson (1980), SIDA (1988), Kayizzi-Mugerwa (1988), Gulhati (1989), Seshamani (1990), Mwanakatwe (1990), Bates and Collier (1992), McPherson (1995). There are also several excellent World Bank reports (World Bank 1977, 1993, 1995). Some Government of Zambia reports are exceptional as well (GRZ 1984, 1989, 1992).

[3] Completing *A Study of Employment in Zambia* (McPherson *et al.* 1978) involved several person years of data analysis in order to obtain times series of sufficient length to make plausible econometric estimates.

[4] The key sources are the *International Financial Statistics (IMF), World Development Indicators,* and *African Development Indicators (World Bank)*. All of these are available on CD-ROM and most of them can be retrieved from the Internet.

[5] An obvious bias is evident in the trends in real GDP. As an economy declines, the rate of collapse tends to be over-stated as an increasing share of economic activity shifts into informal or "unrecorded" activities because asset-holders and entrepreneurs take steps to protect themselves from the disruptions and uncertainty. During periods of recovery, the expansion of real GDP tends to be over-stated as a larger share of informal activity begins to be recorded.

[6] Estimates of the general order of magnitude of resources transferred abroad by Zambian firms and individuals for the period from the late 1970s to 1993 has been provided by two independent sources (one a consultant with long experience in Zambia, the other an embassy economist in Lusaka). Their estimates range from US $12 to 15 billion.

[7] Zambian population statistics records a negative population growth for 1997 and, preliminary, for 1998. On the other hand, due to the good harvest in 1997, there is an increase in agricultural production. That explains the higher GDP per capita rate of growth for 1997 and, possibly, 1998.

[8] Kayizzi-Mugerwa 1990.

[9] Some commentators point to the remarkable growth of non-traditional exports over the last several years. In relative terms, these activities have been exceedingly successful. Three points should be noted however. First, given the virtual non-existence of NTE's before the government began to liberalize the trade and exchange system, there has been a period of "catch-up" growth. Second, many of the NTE's are produced in "enclaves" in Zambia, which have only limited

contact with the local economy. And third, most exporters in the sector operate in dollars (or some foreign equivalent) as a means of insulating themselves from local disruptions. None of these points detract from the performance of the NTEs. For many non-traditional exporters, Zambia provides a convenient platform. A major policy concern is how to strengthen their linkages to the rest of the economy.

[10] Trends in the inflation-adjusted price of copper show that the real export price of copper fell sharply during the 1970s and has never fully recovered. The reasons can be traced to supply and demand. On the supply side, some substantially more efficient copper mines (in Chile, Papua New Guinea) were developed in the mid-to-late 1970s. As a result, Zambia lost its status as a medium cost supplier. At the same time as these other mines came on stream, the rate of investment and innovation in Zambia's mines (which at one time was substantial) declined sharply. The shift to fiber optics and "wireless" technology in the communications sector began to generate larger volumes of copper scrap each year. On the demand side, the end of the Vietnam War and the development of hard plastic cannon shells sharply reduced the amount of copper used in the defense industry. Modifications to automobiles in the wake of the "energy crisis" led to major reductions in the use of copper in the auto industry. For example, an average car in the U.S. was produced using 40 percent less raw copper within a decade. Finally, as communication technology because increasingly "digitized", the requirement for copper wiring has declined. To adjust to these trends, Zambia could have increased its productivity, depreciated its real exchange rate, or reduced its real wages. Since the first two have not occurred, all adjustment over the last twenty years has fallen on average real wages. Zambia borrowed abroad to postpone that. Real wages still have some distance to fall to re-balance the economy *unless* there can be a major real effective exchange rate depreciation and substantial improvement in the overall productivity in the mining sector.

[11] The United Kingdom, Argentina, and many other countries, which had chronically overvalued real exchange rates found that adjustment of some form always occurs. For some countries, there is a major decline in the rate of growth. For others, including Zambia, the adjustment has been occurring through an absolute decline in income.

[12] The three-year ESAF is due to expiring in December 1998 without Zambia having fully met one formal review. At present, the IMF and other donors are *not* looking beyond this program to a potential successor. Such a program will require a dramatic change in economic management in Zambia.

[13] Zambia's economic difficulties led to the accumulation of large external arrears. By the early 1990s, its arrears to the IMF exceeded $1.2 billion. Since the IMF does not reschedule its debts, a mechanism, which *de facto* allowed this to happen was created. Under the Rights Accumulation Program (RAP), Zambia could earn the "right" to repay its arrears using concessional borrowing from the IMF under the Enhanced Structural Adjustment Facility (ESAF) program. After several delays, Zambia completed the RAP in December 1995. At that point its arrears were transformed into a concessional credit.

[14] An earlier contribution (cf. Fernholz *et al.* 1996) argued that the degree to which Zambia depends on foreign aid has had serious adverse effects on the quality of economic management. The government has recognized that aid has serious disadvantages (*MMD Manifesto '96*, page 7). Despite this recognition, the 1998 budget (GRZ 1998) provides dramatic evidence of the high extent to which government policies and programs have become dependent on the continued flow of donor finance. Several items included in the budget (K96 billion for public sector retrenchment, $159 million for balance of payments support, and finance for ROADSIP among other items) had not been secured when the budget was framed. Yet, these were included as key elements of a nominally "balanced" budget.

[15] Zambia provides a modern-day example of how monetary mis-management, as Keynes said, can "debauch" the currency. Writing in 1919, Keynes stated:

> There is no subtler, no surer means of overturning the existing basis of Society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manner which not one man in a million is able to diagnose (Keynes 1963:78.)

[16] In technical terms, Zambia continues to "absorb" more real resources than it generates.

[17] Oil prices in real terms have declined sharply. The real costs of computer and communication technology has fallen dramatically as well.

[18] The *National Mirror* of June 21-27, 1998 had a front page headline "ZCCM bleeding Zambia" which stated that ZCCM's losses were in the order of K2 billion per day (more than $1 million at the current exchange rate). This datum was consistent with a recent article in the *Economist* (May 1998) on Zambia's economic troubles.

[19] *World Economic Outlook* October 1998: Table 8, page 182. These data show that Africa's inflation remain high by world standards. With inflation in the industrial countries lower than 3 percent per annum since 1994, the African inflation is seriously out of line, especially since most exchange rates (including Zambia) have not been moving at rates to compensate for changes in external prices.

[20] The model is presented as volume 4 of World Bank (1977).

[21] For several years, a group from Oxford University headed by Christopher Adam has been working with a team in Zambia to develop such a model.

[22] Kayizzi-Muzerwa 1988; Mwanawina 1995.

[23] An example is given in McPherson (1980). This study, which highlighted the links between employment and growth, produced a 30-sector input-output decomposition analysis and a seven sector econometric model. It used the World Banks BSIMULO-X program to derive projections. An interesting footnote is that this model, which covered the period up until 1979, projected major declines in output and employment in the base run scenario of "no policy change". In the event, Zambia did not make any significant adjustments in policies for more than a decade. This produced a sharp decline in output and employment.

[24] Porter and Ranney 1982; Chand 1989; Khan and Knight 1991.

[25] Many of these spillovers and knock-on effects are the result of growing interdependence and connections created by the globalization of financial, product, factor, and asset markets. The dynamics of many of the linkages are only just being explored (Sachs 1998, Rodrik 1998, Obstfeld 1998.)

[26] The lack of consistency and policy reversals in Zambia have been widely documented. A sample of the literature includes: Dresany 1975; Tordoff 1977; ILO 1977; Baylies 1980; McPherson 1980; Mwaipaya 1980; Szeftel 1982; World Bank 1984, 1986, 1991, 1992; Zuckerman 1986; Wulf 1989; Harber 1989; Callaghy 1990; Fardi 1991; Kelley 1991; *Economist* 1991; West 1992; Bates and Collier 1992; Price Waterhouse 1996; Kasanga 1996, and Hill and McPherson 1998.

[27] Lower-case letters denote the logarithm of the upper-case variables.

[28] Sources include: McPherson 1980; IMF 1981; Porter and Ranney 1982; SIDA 1989; Chand 1989; Goodhart 1989; Khan and Knight 1991; Rajcoomar *et al.* 1996.

[29] Nyoni (1998) recently tested the impact of foreign aid in Tanzania on the real exchange rate. Over the period he considered (1970-93) there was a weak positive relation between aid flows and real exchange rate depreciation. This is contrary to our expectations for Zambia. It is also not consistent with recent findings in Dollar and Pritchett (1998). They show that in non-reforming countries (of which Zambia has been a prime example) foreign aid had a negative effect on government revenue.

[30] This, in fact, may be one reason why aid could be associated with a depreciating exchange rate. By paying fewer taxes, private individuals have higher consumption expenditure. This spills over to imports leading to exchange rate depreciation.

[31] Although students of Zambia's economic history have fully appreciated the role of distance in Zambia's development (cf. UN/ECA/FAO 1964; Baldwin 1966; Bostock and Harvey 1972), recent work by Sachs (1997) and others has begun to examine more systematically the significance of the transport "barrier".

[32] Greene (1993) provides a useful treatment of the basic theory.

[33] A more detailed explanation of the Lucas Critique and the context in which it applies are given in Annex C.

[34] Berg 1996; Brautigam 1996; HIID 1997; Johnson 1997; Dollar and Pritchett 1998.

[35] However, as illustrated during the recent financial turmoil in Asia, raising interest rates will not necessary prevent the exchange rate depreciation. Moreover, as Sweden found in 1992 when it pushed overnight interest rates to levels above 500 percent before devaluing the kronor, raising the interest rate can be a sign of panic. This makes devaluation inevitable.

[36] Zambia has two highly attractive options. The first is to revive the copper mines and bring their output to levels approaching those achieved in the early 1970s. Recent changes in mining technology and innovations in metal processing allow that to be done. Missing so far in Zambia has been the capital and the skilled management needed to take advantage of this opportunity. The second is to take advantage of the livestock/grain connection that linkages to the Asian meat market would provide. Rising productivity in maize and other coarse grain production would benefit local consumers and provide producers with the opportunity to "finish" livestock for the broader export market. Missing so far has been the incentives needed to raise coarse grain production. Also missing has been the initiative, supported by the necessary investment, to raise the production of types of beef which would suit world markets. With increasing pressure on land and rising income in Asia (despite the recent turbulence) there are sound prospects for increasing long-term demand for meat and grain. Zambian producers simply have to determine how (not whether) to become involved.

[37] Following Tinbergen and Theil who developed the theory, there was widespread interest in “optimal” economic policy. The idea was that policy makers should attempt to specify, in a measurable way, the major objectives of policy. Instruments would then be chosen so as to produce the optimal change in the targets according to policy makers’ preferences. The emphasis on this approach has diminished due to the difficulty of finding suitable measures of preferences that are consistent with aggregation conditions required by Arrow's “possibility theorem”.

[38] This is also called the “assignment” problem.

[39] Goodhart 1989.
[40] Lucas 1976.

[41] It has been suggested that economists should specify “policy-invariant” models. This may be possible in developed countries where structural relationships are exceedingly deep. It is irrelevant to developing countries where the principal object of policy change is to transform the economic structure.

[42] References include IMF 1981; Chand 1989; Rajcoomar *et al.* 1996.